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Species of Taphrina on Betula in Slovakia

KAMILA BACIGÁLOVÁ

Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 14,
842 23 Bratislava, Slovak Republic

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New data on the occurrence of *Taphrina betulae* (Fuckel) Johanson and *Taphrina betulina* Rostr. on *Betula pendula* Roth, *Betula pubescens* Ehrh. and *B. pubescens* Ehrh. subsp. *carpatica* (Kit. ex Willd.) Aschers. et Graebn., till now unsufficiently known from the territory of Slovakia are presented. Brief characteristics on biology, ecology and distribution of the fungi as well as their host plants are given together with the ecological characteristics of their localities.

Key words: *Taphrina* Fr., *Betula* L., Slovakia, biology, ecology, distribution

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Autorka uvádza v mykoflóre doteraz málo známe druhy - *Taphrina betulina* Rostr. na *Betula pubescens* Ehrh. a na *Betula pubescens* subsp. *carpatica*, - *Taphrina betulae* (Fuckel) Johanson na *Betula pendula* Roth na Slovensku. Opisuje symptómy ochorenia na hostiteľských rastlinách, anatomicko - morfologické charakteristiky húb, lokality ich výskytu a ich ekologické charakteristiky.

Phytopathogenic fungi of Taphrinales poorly known and very often overlooked till now, represent a natural component of phytocenoses in Slovakia. They cause morphological deformation of branches, leaves and fruits. The most common "witches' brooms" infections in crowns of trees and shrubs, leaf and other infection symptoms on host plants such as *Carpinus, Alnus, Betula* and *Prunus*, are caused by ascomycetous biotrophic fungi in the genus *Taphrina*. Recent works, however, have been concentrated on the infection symptoms, anatomical and morphological characteristics of *Taphrina* fungi on *Alnus, Carpinus, Populus*, their locations and ecological characteristics in Slovakia (Bacigálová 1992, 1994). The paper summarizes results of a mycofloristic research of *Taphrina* fungi on *Betula* host plants and reports on some aspects of the biology of *T. betulina* and *T. betulae*, their infection symptoms in host plant tissue and chorological observations in ecological conditions of the Slovakian territory.

MATERIAL AND METHODS

The studied material of *Taphrina* fungi on *Betula* species as host plants was obtained from collection samples of mycofloristic research in Slovakia and from existing herbarium items at the following institutes: Mycological Herbarium

Fig. 1. *Betula pubescens* carrying multiple *Taphrina betulina* infections throughout the crown.

of the Slovak National Museum, Bratislava - BRA; Mycological Department, National Museum Prague - PRM; Department of Botany, Faculty of Natural Sciences, Charles University, Prague - PRC; Department of Botany, Natural History Museum Viena - W;

For identification of the *Taphrina* species both visual symptoms of infected trees and anatomical- morphological characteristics of the fungi were used. They were observed by taking cross and longitudinal sections from naturally infected *Betula* leaves or twigs and observed in a drop of 50 % lactic acid. An evaluation was made by means of Zeiss "Amplival" microscope with microphotographic equipment.

The species of the genus *Taphrina* were identified according to Mix (1949), Sałata (1974) and host plants according to Dostál and Červenka (1991). The

localities of the fungi and their host plants are reproduced in maps. A list of localities grouped according to their phytogeographical classification (Futák 1966) is compiled.

The collected specimens of *Taphrina* are deposited in the Herbarium of the Institute of Botany, Slovak Academy of Sciences - SAV.

Notes: R.- river, B.- brook, surr. - surroundings

Taphrina betulina Rostr.

Syn.: *Exoascus betulinus* (Rostr.) Sadeb., *Exoascus turgidus* Sadeb., *Taphrina turgida* (Sadeb.) Giesenh., *Taphrina lagerheimii* Palm

Symptoms. The fungus causes "witches' brooms" on species of *Betula* L. (*B. pubescens, B. pubescens* subsp. *carpatica* and *B. pendula*) (Fig. 1). On young brooms, the infected bud gives rise to the main shoot with a thick swollen base compared to those found on normal branching shoots. The axillary buds at the base of the shoots are swollen developing further in the following growing season (Fig. 2a).

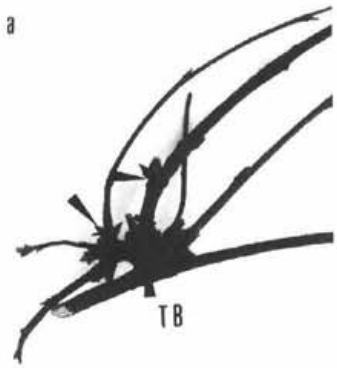

Fig. 2. a) Young "witches' brooms" caused by *Taphrina betulina* on *Betula pubescens*. Note the typically thickened base (TB) and the presence of swollen axillary buds (arrowed) at the base of this shoot.

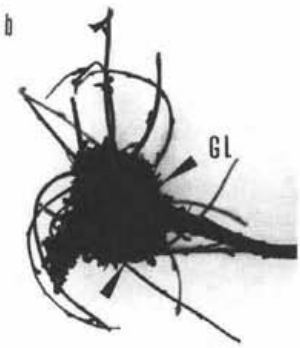

Fig. 2. b) The shoots on older "witches' brooms" are narrow at the base (arrowed) and arise from a gall-like (GL) structure of the broom on the branch.

Shoots developing on older brooms are narrow at the base, and arise from a gall-like structure at the centre of the broom on the branch of a tree (Fig. 2b). The gall appears to grow through the swelling of tissues surrounding the infected axillary bud. Abundant pubescence was present on both the epidermis and leaves of the shoots developing from these brooms. Many of the shoots show very rapid

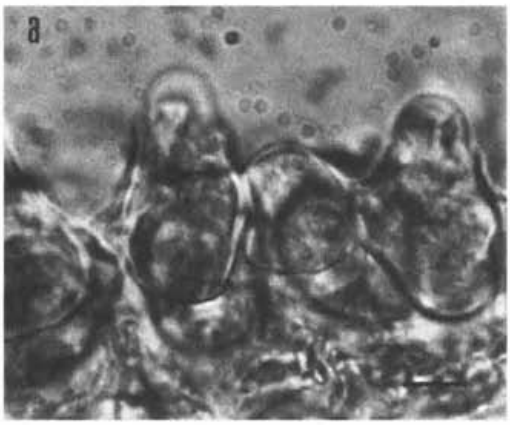

Fig. 3. a). Maturing ascogenous cells of *T. betulina* in the subcuticular layer of the leaves of *B. pubescens*, —— 10 μm.

Fig. 3. b). Mature asci of *T. betulina* with ascospores and blastospores, —— 10 μm.

growth, but the longest shoots often die in their first winter. *Taphrina betulina* infections multiply themselves and the diameter of broom increases with the age of the birch tree and are often over 100-150 mm in diameter and 1 m long. Asci of the pathogen are present on the leaves remaining attached to the shoots. In spring they are pale-green to yellowish, more or less concave but not thickened, later they dry up, blacken from the edge inwards and abscise a little time after their browning. The large central gall-like structures with the surrounding mass of living and dead shoots (older brooms), form suitable habitats for many small insects.

Anatomical and morphological characteristics. The vegetative mycelium is subcuticular and perennial between the epidermal cells of the host tissue. During their further development the size of the mycelium cells increases; the cells become strongly thickened and are disintegrated into thick-walled ascogenous cells. The ascus arises by the splitting of the outer ascogenous cell wall, which allows the inner membrane to form a papilla (Fig. 3a). Asci hypophyllous, cylindric, rounded or truncate at the apex, provided with stalk cells which may be broad and sessile, or wedge shaped and inserted between the epidermal cells (Fig. 3b). On one leaf both cylindric and more elliptical asci were often found. The variability of the size of the asci is demonstrate in Table 1. The asci have eight ascospores. They are ovate to elliptic, 4.5-6 × 4-5 μm, frequently budding in the ascus filling it with smaller, ovate or elliptic blastospores 3-4 × 4-5 μm.

Locations of the fungus and their ecological characteristics. *T. betulina* was collected on *B. pubescens* and *B. pubescens* subsp. *carpatica* by Greschik at Levoča in 1917, 1923 (SNM) and 1918 (Jeschková 1957). Later the fungus was collected by Skalický in 1955 in Vysoké Tatry Mts., around Tatranská Lomnica (PRC). Our mycofloristic observations confirmed the occurrence of the fungus mainly in the Carpatian Mts. New localities have been discovered in submontane to montane belts up to the elevation of 1 000 m alt. on birch trees along main roads (Čertovica - Nízke Tatry Mts., Tatranská kotlina - Vysoké Tatry Mts.), along a tourist track and on solitary in trees parks in the Vysoké Tatry Mts. region in the extreme thermal and humidity conditions in the dwarf pine zone up elevations of 1500 m alt.

List of locations (Fig. 4)

On *Betula pubescens* Ehrh.: 22. Nízke Tatry Mts.: Čertovica - Vyšná a Nižná Boca, along the main road; 1983, 1988, 1995; 23a. Západné Tatry Mts.: Žiarska dolina Valley near Žiarska cottage; 1988, 1993; 23b. Vysoké Tatry Mts.: Štrbské Pleso, in the park; 1992; between Štrbské Pleso and Popradské Pleso, on the red marked tourist track; 1988, 1990, 1991, 1992; Vyšné Hágy near the railway station; 1991; Tatranská Polianka, in the park; 1988, 1995; Starý Smokovec, in the park; 1988, along the main road; 1989; omnia leg. Bacigálová (SAV); Tatranské Matliare, in the park; 1955; Nový Smokovec, 1955; omnia leg. Skalický (PRC); Tatranská Lomnica, in the park; 1988, 1990, 1992; Kežmarska Biela voda Valley - Šalviový prameň Spring; 1987, 1990; Matejovce, in garden in the Village; 1987; 23c. Belianske Tatry Mts.: Tatranská Kotlina, along the main road; 1988, 1995; Ždiar, in the Village and along the main road; 1988, 1995; 26b. Spišské kotliny Basin: Štrba (virgin forest near Štrba); 1986; omnia leg. Bacigálová (SAV). 29. Spišské vrchy Mts.: Levoča, leg. Greschik, 1917 (SNM).

On *Betula pubescens* Ehrh. subsp. *carpatica* (Kit. ex Willd.) Aschers. et Graebn.: 23a. Západné Tatry Mts.: Kamenistá dolina Valley, along tourist track; 1988, 1993; Kôprová dolina Valley, near Kôprový B.; 1987; 23b. Vysoké Tatry Mts.: Mengušovská dolina Valley - between Štrbské Pleso and Popradské Pleso, on the red marked tourist trach; 1990; Štrbské Pleso, near the Post office; 1992, 1995; omnia leg. Bacigálová (SAV); Nový Smokovec; 1955, leg. Skalický (PRC); Obrovský vodopád Waterfall; 1988; Malá studená dolina Valley along the tourist track; 1990; Lomnický hrebeň 1 540 m a.s.l. near the tourist track; 1988; Tatranská Lomnica; 1989; omnia leg. Bacigálová (SAV); Matliare, near Tatranská Lomnica; 1955; leg. Skalický (PRC); Kežmarska Biela voda Valley 1200 m a.s.l.; 1987, 1990, 1995; Zelené pleso Valley, near Brnčalova chata Chalet, 1500 m a.s.l.; 1987, 1988, 1990; 26b. Spišské kotliny Basin: Štrba, virgin forest near Štrba, 1986; omnia leg. Bacigálová (SAV). 29. Spišské vrchy Mts.: Levoča; 1923; leg. Greschik (SNM).

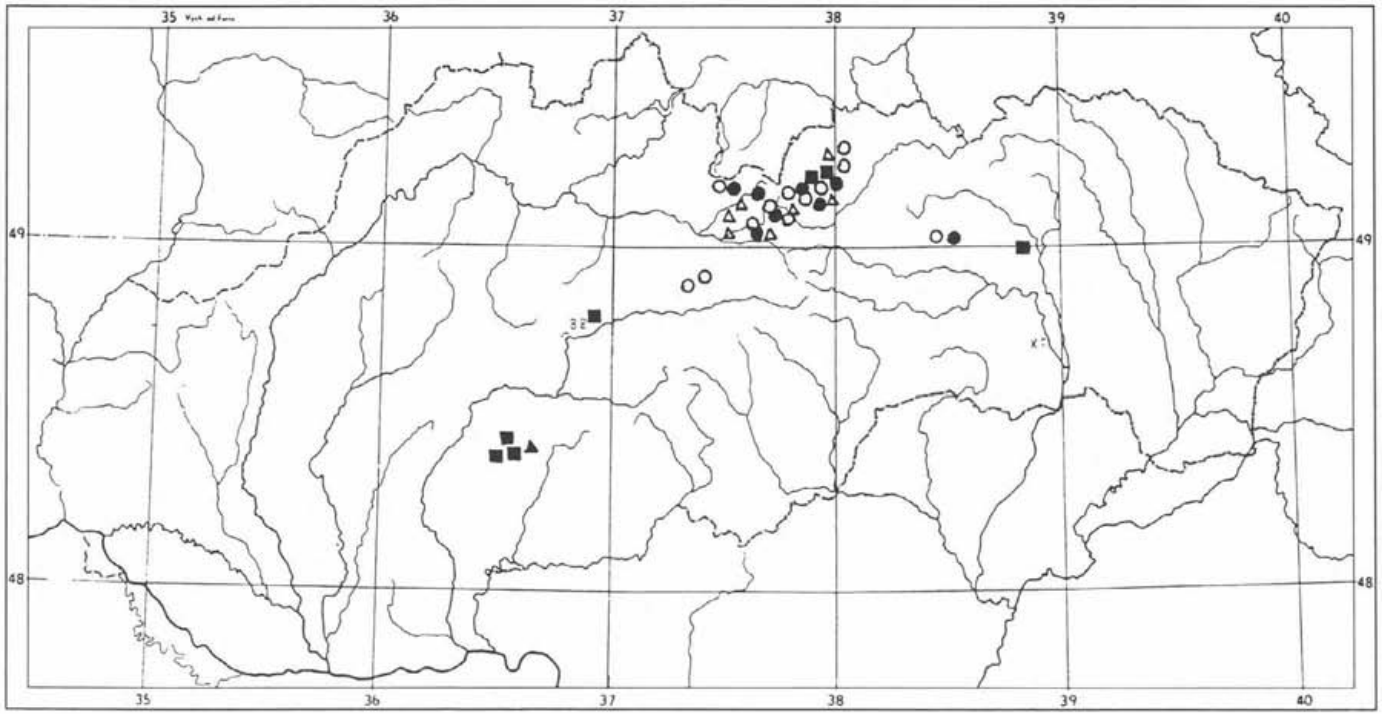

Fig. 4. Distribution map of *T. betulina* on *Betula* sp. - △, on *Betula pubescens* - ○ and on *Betula pubescens* subsp. *carpatica* - ●; of *T. betulae* on *Betula* sp. - ▲, on *B. pendula* - ■.

On *Betula* L.: 23a. Západné Tatry Mts.: Tichá dolina Valley, 1988; Podbanské, near Tri studničky; 1988; 23b. Vysoké Tatry Mts.: Štrbské Pleso, in garden near rack railway; 1987; Horný Smokovec near railway line; 1988; Hrebienok, 1988; Pekná vyhliadka, near the railway station; 1988; Stará lesná, near the railway station; 1988; Tatranská Lomnica; 1988, 1991; 26a. Liptovská kotlina Basin: Východná - Važec, along the main road; 1987; Važec - Štrba along the main road; 1989; 26b. Spišské kotliny Basin: Štrba - Lučivná, along the main road; 1988; 29. Spišské vrchy Mts.: Bachledova dolina Valley, 1988; omnia leg. Bacigálová (SAV).

Taphrina betulina is wide spread on various species of birch, but most of all in the North of Europe. In Norway the fungus occurs on *B. pubescens* Ehrh., *B. pendula* Roth, *B. nana* L., *B. alpestris* Fr. and *B. lenta* L. (Gjaerum 1964), in the United Kingdom (Scotland) *Betula pubescens* Ehrh. is more frequently infected by *Taphrina betulina* than *Betula pendula* (Jump and Woodward 1994), in Poland it occurs on *Betula pubescens, Betula pendula* and *Betula pubescens* subsp. *carpatica* (Sałata 1974). Further *Taphrina betulina* on *B. pubescens* has been found in Germany by Ludwig, 1926,1927 (W); (Poelt and Scheuer 1991) in Bohemia and Moravia (Jeschková 1957). In Southern Europe the fungus occurs on birch trees in the northwestern Vitosa Mts. in Bulgaria (Naidenov 1986).

The fact that fungus cause infections of various species of birch evoked numerous discussions about the fungus species, forms and synonymy of *T. betulina* (Mix 1949, Gjaerum 1964). We also found some differences in morphology of whitches' broom formations in the crowns of birch trees. The size of the asci is also variable, as we can see in Table 1.

Although witches' broom infections have not been considered an important disease, the possibly increased use of birch as a productive timber tree in some countries, will necessitate considering the possible impact of these infections. Spanos and Woodward (1994) recorded birch growth reductions of over 25%, which could seriously affect the economic viability of birch plantations. Mycofloristic observations made for this study show, that infections of birch in Slovakia are not so important as in Scotland or in other Nordic countries.

Taphrina betulae (Fuckel) Johanson

Bas.: *Exoascus betulae* Fuckel
Syn.: *Taphrina auctumnalis* (Sadeb.) Palm

Symptoms. The fungus causes small rounded (up to 10 mm large) pale green to yellow non-thickened spots on the leaves of Betula pendula Roth. In the period

Table 1 Variability of *Taphrina betulina* asci at different locations.

Locations	Ascus — size in μm	Stalk cell — size in μm
Malá studená dolina Valley	16–48 × 11–22	3–16 × 10–38
	(32–35 × 16–19)	(6–16 × 16–22)
Kamenistá dolina Valley	32–51 × 12–16	6–17 × 19–25
	(32–38 × 16)	(6–8 × 22–26)
Zelené Pleso Valley	35–50 × 19	13–15 × 19
Štrbské Pleso, in park	24–73 × 10–25	3–22 × 16–41
	(32–48 × 16–22)	(6–16 × 19–32)
Starý Smokovec, in the Village	32–67 × 12–22	3–28 × 12–28
	(41–48 × 13–16)	(9–22 × 16–19)
Tatranská Lomnica, in park	35–76 × 12–22	6–38 × 12–35
	(48–64 × 16–19)	(6–10 × 16–25)
Žiarska dolina Valley	48–58 × 22–26	10 × 32
	(38–69 × 15–23)	
according the authors:		
Najdenov (1986)	45–55 × 10–15	
Mix (1949)	23–73 × 10–26	7–27 × 10–30
Sałata (1974)	23–80 × 12–27	8–23 × 12–30
Gjaerum (1964)	36–96 × 11–23	

of maturing asci the spots are greyish, turn brown later, become dry and remain on the living leaves (Fig. 5).

Anatomical and morphological characteristics. The vegetative subcuticular mycelium is richly branched and disintegrate into short cells that develop into thick-walled, irregularly shaped ascogenous cells (Fig. 6a). Later, the ascogenous cells increase in length and asci are formed. Asci epiphyllous, hypophyllous or amphigenous, cylindric, rounded or truncate at the apex, sometimes broadened at the base. Stalk cells sessile, broad and flat, sometimes broader than the ascus or isodiametric (Fig. 6b). The dimensions of the asci are 17-39 × 7.7-17 μm, of the stalk cells 3.1-15.4 × 3.1-18.5 μm, but most frequently they are 18.4-27.7 × 9.2-12.3 μm

Fig. 5. Greyisch moderate-sized spots caused by *Taphrina betulae* on living leaves of *Betula pendula*.

with stalk cells 6.2-12.3 × 7.7-15.4 μm. Ascospores eight, ovate or to elliptic, they are 4.6 × 6.2 μm, sometimes budding in the ascus.

According to Mix (1949) they are 17-46 × 8-18 μm, stalk cells 7-17 × 8-30 μm; according to Salata (1974) most frequently 25-35 × 8-12 μm, stalk cells 6-17 × × 8-30 μm and according to Gjaerum (1964) the asci are 20-44 × 9-18 μm.

Locations of the fungus and their ecological characteristics.

Taphrina betulae was collected by Bäumler at Pozsony (Bratislava), by Kmeť at Prenczfalu near Szitnya (Prenčov, Sitno), by Hazslinszky at Eperjes (Prešov) on *Betula pendula* (Moesz 1939), and by Kmeť at Prenčov, 1898 on Betula sp. (Jeschková 1957).

New locations of this so far very rare fungus not only in Slovakia were found during our mycofloristic observation on *B. pendula* only at two sittes situated in valleys of the Vysoké Tatry Mts. and in one location in Nízke Tatry Mts. near a tourist track at an elevation of 1200 m alt. The fungus was not found at the old locations in east, central and west Slovakia detected by Kmeť, Bäumler and Hazslinszky.

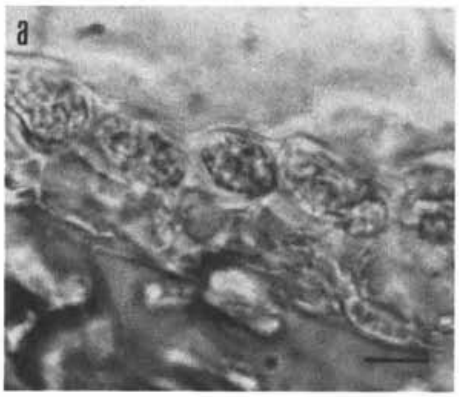

Fig. 6. a). Mycelium cells become enlarged to form ascogenous cells in the subcuticular leaf layer, —— 10 μm.

Fig. 6.b). Mature asci of *T. betulae* with ascospores, —— 10μm.

List of locations (Fig. 4)

On *Betula pendula* Roth (syn. *B. alba* L., syn. *B. verrucosa* Ehrh.): 10. Malé Karpaty Mts.: Pozsony (Bratislava) Bäumler (Moesz 1939); 14e. Štiavnické vrchy Mts.: Čabradský vŕšok; 1877; leg. Kmeť (PRC); Prenčov near Mt. Sitno; 1898; leg. Kmeť (SNM); 22. Nízke Tatry Mts.: Špania dolina Valley; 1985; leg. C. Paulech (SAV); 23b. Vysoké Tatry Mts.: Kežmarská Biela vodaa Valley near Šalviový prameň; 1987, 1988, 1990; Mengušovská dolina Valley, near tourist track; 1990, omnia leg. Bacigálová (SAV); 30a. Šarišská vrchovina Mts.: Eperjes (Prešov), Hazslinszky (Moesz 1939);

On *Betula* L.: 14e. Štiavnické vrchy Mts.: Prenčov; 1882; Prenčov - Sitno; 1898, 1898, 1899; Prenčov - Badaň; 1899; omnia leg. Kmeť (SNM).

The fungus occurs predominantly in North Europa in Scandinavian countries as a biotrophic parasite on *B. pendula* and *B. pubescens*. According to Gjaerum (1964), the fungus is known on *B. pubescens* from localities scattered all over Norway, but on the host *B. pendula* it occurs only in the central regions. In Poland the fungus occurs on *B. pendula* and only at one location on *B. oycowiensis* (Sałata 1974). The new locations of the fungus were found in the north Slovakia in Vysoké Tatry Mts. They are very few and the fungus occurs only on the birch *B. pendula* situated in mountain valleys at elevations up to 1 000 m alt. Ecological conditions of those locations correspond with Northern European climate conditions (Bacigalova 1997). According to Zerova (1969) the fungus occurs on *B. pendula* also on the territory of the East Carpathian Mts. in the Ukraine.

SUMMARY

The paper deals with biotrophic fungi of *Taphrina* (*T. betulina, T. betulae*) parasitizing on *Betula* species (*B. pubescens, B. pubescens* subsp. *carpatica, B. pendula*), till now unsufficiently known from the Slovak territory. Several years of mycofloristic observations have shown that the species *T. betulina* and *T. betulae* occur only in the higher vegetation range with a colder and a more humid climate in central and north Slovakia. The author presents new data on biology, ecology and distribution of the mentioned fungi as well as their host plants. The ecological characteristics of the new locations are described.

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